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Risk scores: a guide in clinical practice?

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General discussion

In this thesis several studies are presented that together aim to investigate the extent of guideline adherence in the management of patients diagnosed with non-ST-elevation acute coronary syndrome (NST-ACS), with emphasis on the use of cardiac risk scores (e.g. GRACE or TIMI risk score) in clinical practice. Another aim was to identify determinants for suboptimal cardiac risk score use. Furthermore, the importance of different components of clinical information, including risk score outcomes, on cardiologists decision-making regarding performing coronary angiography was studied. Quantitative and qualitative study designs have been used.

In this chapter, the main findings are presented in section 8.1 and subsequently discussed in section 8.2. In section 8.3 possible methodological issues are discussed, in terms of strengths, limitations, and generalizability of the study results. In section 8.4 implications for clinical practice and future research are outlined. Finally in section 8.5 conclusions are presented in light of the research questions.

8.1 Overview of main findings

8.1.1 What is the extent of guideline adherence in patients with NST-ACS?

The extent of adherence to international cardiac guidelines, i.e. the ESC and ACC/AHA guidelines, varied widely between studies included in our systematic review (*Chapter 2*). Adherence rates between 5.0% and 95.0% were found for acute and discharge pharmacological care, and between 16.0% and 95.8% for performing coronary angiography (CA). Only a few studies looked into the use of different risk stratification methods (e.g. troponin measures, performing an ECG, use of cardiac risk scores), for which adherence rates were found varying between 34.3% and 93.0%. Lower guideline adherence was consistently found to be associated with poorer prognosis. Yet, none of the studies regarding the extent of adherence to risk stratification methods looked into this relationship.

In a cross-sectional multicentre study (*Chapter 3 and 4*) we further studied the extent of guideline adherence in NST-ACS care, but with specific attention to the use of validated cardiac risk scores in clinical practice. Data of 1788 patients discharged with a diagnosis of NST-ACS were analysed. Consistent with the findings from the systematic review, large variation in adherence rates was found. On average in 57.0% of the cases a cardiac risk score was documented in the patient's chart. For the thirteen hospitals included in the study, adherence rates ranged from 16.7% to 87.0%.

8.1.2 Which factors are associated with cardiac risk score use?

To find a possible explanation for the variation found in cardiac risk score use between hospitals, we studied the association between several clinical or contextual factors and the extent of guideline adherence. Factors derived from our systematic review (*Chapter 2*) were related to guideline adherence in the management of NST-ACS in general, and are therefore not further elaborated below.

Similar to previous literature [1-3] on the subject of influential factors (i.e. barriers or facilitators) in relation to the implementation of guidelines, factors associated with the extent of cardiac risk score use were either related to the guideline itself, the patient, the healthcare provider or the organization. With exception of some of the factors found to be related to the patient, all factors are derived from semi-structured interviews with 31 healthcare providers from 11 hospitals (*Chapter 5*).

Guideline related factors

Five factors influencing cardiac risk score use were related to the risk score itself (Table 8.1). First, the lack of a clear clinical relevance of the risk score was an important influential factor. With clinical relevance referring to either proven benefits on a patient level in terms of a reduced risk of dying or myocardial infarction, or to benefits for clinical practice in terms of improved continuity of care. It was often mentioned by healthcare providers that a clear clinical relevance of the risk score would be a major facilitator, and would reduce resistance among its intended users. Hospitals with high percentages of risk score use, often incorporated risk score outcome categories (i.e. low, intermediate, high) in existing clinical pathways or protocols, and in that way made a direct link to treatment choices, which made the relevance of the risk score more pronounced. A lack of clinical relevance was either a reason not to use a risk score at all, or led to risk score use for administrative purposes only instead of as a guide in decision-making.

Second, the lack of a clear scientific evidence base, e.g. (quasi) experimental studies supporting the use of a risk score in terms of improved patient outcomes, made healthcare providers hesitant to base any treatment decisions on the outcome of the score. Risk scores were often used due to external pressure, but not actually influenced decision-making. Extrinsic motivations for cardiac risk score use mentioned by health care providers were for instance the fact that risk scores are strongly recommended in international clinical guidelines, or the use of risk scores being a performance indicator of the national quality improvement program (VMSzorg) adopted by different stakeholders (e.g. Dutch healthcare inspectorate or healthcare insurance companies).

Third, the complexity of the risk score was a frequently mentioned barrier. Not every risk score was perceived as user-friendly. For instance, the GRACE risk score [4,5] was experienced as highly complex in its use as it could not be calculated rapidly at the patient's bedside, but required the necessary information technology (IT) support which was not always present in every hospital or hospital-department.

Fourth, as IT support was often lacking in many organizations, healthcare providers experienced a high administrative burden and time loss associated with cardiac risk score use, which increased resistance to the use of these instruments in clinical practice.

Fifth, frequent updates of clinical guidelines was another barrier in risk score use. While practitioners were still in the process of implementing guideline recommendations of previous guideline versions in their own protocols or standards, new guidelines emerged with updated recommendations. This made it difficult to sustain cardiac risk score use over time.

Table 8.1 Factors related to the guideline

Guideline related factors	Direction of Adherence
(Lack of) Clinical relevance of guideline (i.e. benefits for patient and/or clinical practice)	↓↑
(Lack of) scientific evidence base	↓↑
Complexity of underlying algorithm of risk score	↓↑
Administrative burden / time loss	↓
Fast update of guidelines	↓

↓, lower guideline adherence; ↑, higher guideline adherence; ↓↑ associated with both lower and higher guideline adherence

Patient related factors

Several characteristics related to the patient were associated with risk score use (Table 8.2). In our patient chart review (*Chapter 3 and 4*), six (out of 26 clinical factors) were significantly associated with cardiac risk score use ($p \leq 0.05$). Risk scores were more often used in obese patients (OR 1.49, 95%CI 1.03 – 2.15)¹ and in former smokers (OR 1.56, CI 95% 1.15 – 2.11). By contrast, risk scores were less likely being used among patients diagnosed with unstable angina compared to patients diagnosed with NSTEMI (OR 0.60, CI 95% 0.46 –

¹ Abbreviations: OR, odds ratio; 95%CI, 95 percent confidence interval

0.77), in patients who were resuscitated when presenting in the hospital (OR 0.23, CI 95% 0.09 – 0.64), in patients with in-hospital heart failure (OR 0.46, CI 95% 0.27 – 0.76), and in patients with tachycardia (OR 0.45, CI 95% 0.26 – 0.75). In addition, in *Chapter 5*, healthcare providers questioned whether risk scores could cover the full spectrum of NST-ACS patients. Therefore they did not always trust or use the risk score, e.g. in case of patients with severe comorbidities or in the elderly.

Table 8.2 Factors related to the patient

Guideline related factors	Direction of Adherence
High age, cognitive impairment, immobility†	↓
Diagnosis of UA (versus NSTEMI)	↓
Tachycardia, in-hospital heart failure, in-hospital resuscitation	↓
Obesity, former smoker	↑

† factors are derived from interviews with healthcare providers, all other factors were significantly ($p \leq 0.05$) associated with cardiac risk score use in multivariable analyses.

↓, lower guideline adherence; ↑, higher guideline adherence

Healthcare provider related factors

Several factors influencing cardiac risk score use were related to the healthcare provider (Table 8.3). In our interview study the importance of intrinsic motivations for change versus external pressure became more clear. *First*, the most common intrinsic motivation mentioned was the need for a more uniform approach in treatment practices for patients presenting with suspected NST-ACS in hospital. Cardiac risk score use indeed led to more uniformity in treatment practices and as a result healthcare providers believed that this enhanced patient safety, efficient resource use, and a more rapid identification of high risk patients who would benefit most from invasive and timely treatment. *Second*, cardiac risk scores were implemented for educational purposes, and created more awareness among less experienced physicians for assessment of a patient’s risk of re-infarction or death. *Third*, risk scores were considered of value for scientific research, in which risk scores were used by physicians to study severity of illness among their own population of patients. However, regardless of a healthcare provider’s motivation for cardiac risk score use, users of risk scores feared for overregulation of the process of NST-ACS care. Healthcare providers mentioned that the risk of cardiac adverse events could possibly be overestimated and that treatment policies should thus not be solely based on a risk score outcome.

The scores were in the majority of cases used as a guide in decision-making, combined with conventional risk assessment methods (e.g. troponin measures), and were used to decide on appropriate treatment, to guide admission, or to enhance throughput of patients to other hospital departments. Furthermore, the score was used as an objective support system to quantify a physician's own risk assessment, in order to confirm their assumptions regarding a patient's risk and/or to justify their chosen treatment plan. However, it was frequently mentioned by healthcare providers that if a clear clinical relevance and/or intrinsic motivation for change was lacking, cardiac risk scores were solely used for administrative purposes to meet demands from third parties or stakeholders. In that case implementation of cardiac risk scores was mainly driven by external pressure, and this increased resistance instead of commitment to cardiac risk score use. Although external pressure led to resistance, it also accelerated the use of risk scores in practice. The performance indicators mentioned in the national quality improvement program (VMSzorg) stimulated the use of cardiac risk scores, and partly due to its obligatory character, all hospitals aimed to follow the recommendations of the improvement program. Just as the incorporation of cardiac risk scores in the ESC guidelines accelerated the implementation process in several hospitals. However, several healthcare providers questioned whether hospitals would continue to use cardiac risk scores in daily practice without this external pressure being present.

Other factors that were mentioned by healthcare providers as barriers in using or implementing a risk score in practice were: a lack of familiarity, lack of knowledge, lack of agreement, older age, and more years of work experience. In the latter case, it was suggested that older, more experienced, cardiologists were more likely to base treatment decision on their own gained knowledge over the years, instead of using risk scores, than less experienced physicians.

Table 8.3 Factors related to the healthcare provider

Healthcare provider-related factors	Direction of Adherence
Intrinsic motivations for change	↑
Extrinsic motivations for change	↓↑
Lack of clinical relevance	↓
Physician's characteristics: level of work experience	↓
Lack of familiarization with new practices	↓
Lack of knowledge	↓
Lack of agreement / commitment	↓↑

↓, lower guideline adherence; ↑, higher guideline adherence; ↓↑ associated with both lower and higher guideline adherence

Organization related factors

Although in our patient chart review (*Chapter 4*) we did not find a significant association between characteristics of the organization (i.e. the presence of on-site revascularization facilities (i.e. CA, PCI and/or CABG) and a hospitals’ teaching status) and cardiac risk score use, from the interviews (*Chapter 5*) with healthcare providers several organization-related factors emerged that were either seen as facilitators or barriers (table 8.4).

The absence of necessary resources, in the case of cardiac risk scores the availability of the necessary IT support, was a major influential factor in either enhancing or decreasing the use of risk scores in practice. The same accounted for the available management support, and the priority that was given by hospital management to the use of cardiac risk scores in patient management. Hospitals in which it was for instance possible to incorporate a risk score calculator in existing electronic hospital systems, and hospitals in which staff-physicians or other healthcare providers actively supported and emphasized the importance of using such an instrument in practice, had higher rates of cardiac risk score use. Furthermore, in these hospitals strategies such as frequent reminders and data feedback were used to enhance cardiac risk score use, leading to more intrinsically motivated users of cardiac risk scores. In hospitals where this kind of support was lacking or was absent, resistance among users had the over hand, and risk scores were only used to – as mentioned before – comply with demands of external parties.

Besides a lack of resources, other barriers that were frequently mentioned by health-care providers were: high workload, lack of time and the fast rotation of staff. The latter made it difficult to sustain cardiac risk score use, as frequent rotation of medical interns or medical residents led to a knowledge deficit, and continuously demanded education and training by staff-physicians. Time constraints and a high work load hampered physicians to get familiarized with the guideline recommendations, and in that way led to a knowledge deficit.

Table 8.4 Factors related to the organization

Organization-related factors	Direction of Adherence
Lack of resources: IT support	↓↑
Management support / priority	↓↑
High workload	↓
Lack of time	↓
Frequent staff rotation	↓
Unexpected circumstances at staff level	↓

↓, lower guideline adherence; ↑, higher guideline adherence; ↓↑ associated with both lower and higher guideline adherence

8.1.3 What is the importance of various types of clinical information, including cardiac risk scores, in deciding on the management of patients with NST-ACS?

Cardiac clinical guidelines recommend that physicians make use of multiple clinical factors when deciding on performing coronary angiography in NST-ACS patients [6,7].

However, there is little insight in how physicians' weigh different clinical information when deciding on the treatment of these patients, and to what extent cardiac risk score instruments are part of the decision-making. A nationwide survey was conducted (*Chapter 6 and 7*), in which cardiologists were asked to decide for clinical vignettes whether or not to perform CA. Cardiologists were divided in two groups, with one group receiving clinical vignettes without risk score information present, and the other group receiving vignettes with risk score information present. In both groups decision-making was mainly driven by three sources of clinical information, namely troponin levels, ECG changes and a patient's renal function. Cardiologists were more likely to perform CA in patients with elevated troponin levels and in patients with typical ischemic changes on the ECG. In patients with severe renal dysfunction cardiologists were less likely to perform CA. Persistent complaints of chest pain, previous coronary artery disease and presence of risk factors hardly influenced cardiologists' decision-making. Since effects of risk score were highly associated with age, no firm conclusions could be drawn about the effect of risk score or age separately on cardiologist decisions. However, looking at a combined factor of age and risk score, a significant association was found with performing CA, with cardiologists being more hesitant to perform CA in elderly patients with high risk score according to a validated risk score, than in younger patients with intermediate risk.

To summarize:

- Adherence to cardiac guideline recommendations in the management of NST-ACS varies widely, where rates for cardiac risk score use may be less than 25.0% or more than 80.0%.
- The extent of guideline adherence is associated with several factors, and can be summed under the following categories: risk score, patient, healthcare provider and organization. Factors were studied more extensively in a qualitative study in which a division between intrinsic motivations and extrinsic motivations for cardiac risk score use became clear, with the type of motivation being determinative for whether or not the risk scores are actually adopted by healthcare providers and subsequently its use is sustained in practice.
- Physicians primarily based their decision-making regarding performing coronary angiography on three sources of clinical information, with elevated troponin levels and typical ischemic changes on the ECG making cardiologists more likely to perform CA, and severe renal dysfunction making cardiologists less likely to decide on CA.

8.2 Interpretation of main findings

In NST-ACS, higher rates of guideline adherence are associated with improved patient outcomes, in terms of death and/or re-infarction [8]. Evidence based practice, in which care is provided according to the latest scientific evidence, i.e. by adhering to the available clinical practice guidelines, seems therefore obvious. However, our study results show a large variation in adherence rates in NST-ACS care. The same holds for the application of cardiac risk scores in clinical practice where a large variation in cardiac risk score use was seen between hospitals.

Over the years, several studies have been conducted regarding the accuracy of clinical prediction models, like for cardiac risk scores, in risk assessment and clinical decision-making [9-11]. These studies demonstrated that well-developed and extensively validated risk scores are objective and can more accurately weigh a large number of factors simultaneously than a physician can without support of such a model. In several studies it is demonstrated that using risk scores in addition to conventional risk assessment (i.e. clinical judgement) for decision-making in NST-ACS is superior to conventional risk assessment alone [4,12-17]. Furthermore, in the latest ESC and ACC/AHA guidelines the use of risk scores in risk assessment and decision-making regarding appropriate treatment is a class I² recommendation [6,7]. Although the available scientific evidence summarized in the clinical guidelines speaks for a more consistent use of risk scores in daily practice, our study results show that a large variability in use still exists. Profession-wide there is an agreement that risk scores are beneficial for clinical practice and should be used, this reflected in recommendations in available evidence based clinical practice guidelines for the management of NST-ACS. However, in clinical practice, at the point of care, there seems to be a lack of agreement and in some cases a lack of intrinsic motivation to use risk scores when deciding on the treatment for an individual patient.

Looking at the process of decision-making explained by Kahneman [18,19], physicians' (i.e. cardiologists') decision-making seems to be mainly based on the intuitive system, i.e. highly depended of previously gained experience and a person's own clinical assessment of the situation, in combination with a common focus on a limited number of clinical factors. When cardiologists are presented with simulated patient cases of NST-ACS, and were asked to decide on performing coronary angiography or not, they tended to primarily focus on a limited number of factors, being troponin levels, ECG changes and a patient's renal status. Furthermore, a treatment risk paradox seemed apparent. In clinical vignettes representing

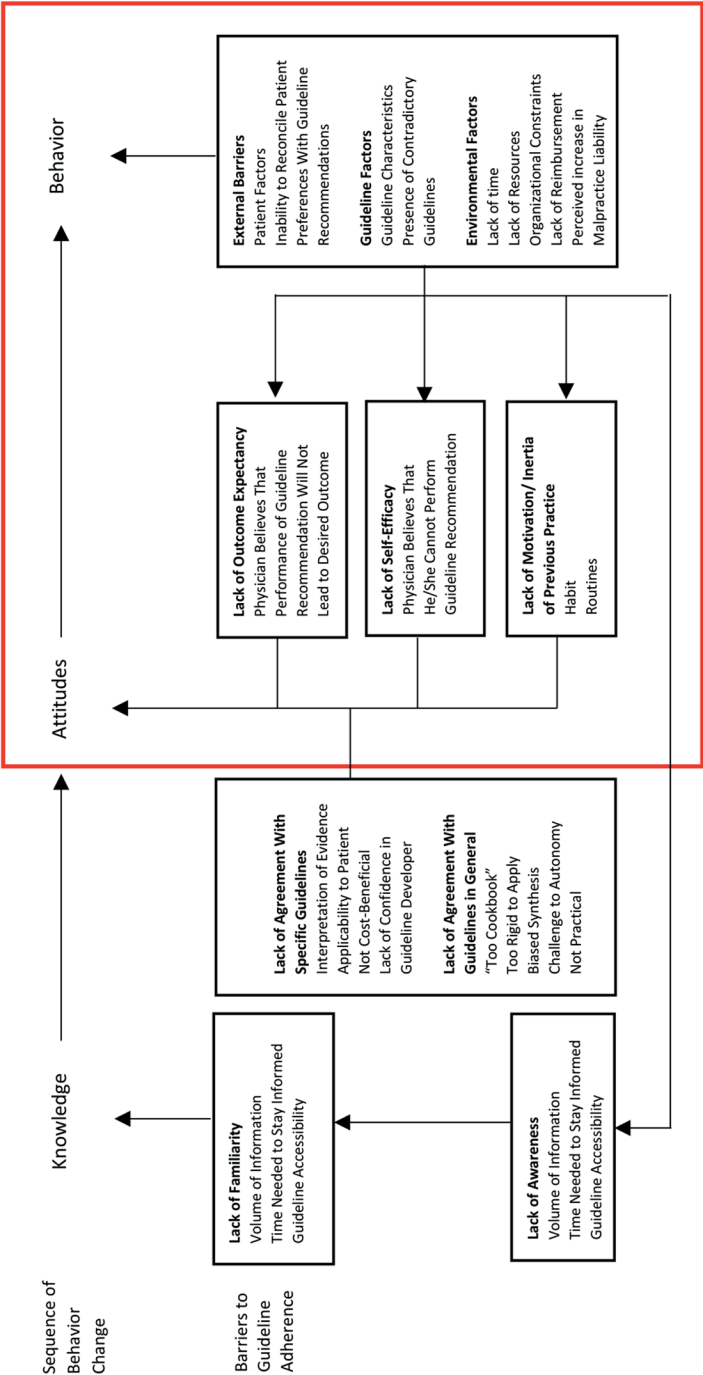
2 Class I recommendation refers to: 'the condition in which there is evidence or general agreement that a certain procedure or treatment is beneficial, useful, effective, and thus recommended/should be performed'[6,7].

high risk NST-ACS patients (i.e. with severe renal failure, or both a high age and high risk of adverse events according to a validated risk score) cardiologists were hesitant to perform CA, compared to patients without such characteristics. Previous literature regarding the treatment risk paradox, showed similar results, with physician's decision-making being mainly driven by an assessment of certain factors, and possibly neglecting others [13,15,16]. In high risk patients, such as the elderly or patients with comorbidities, cardiologists tended to underestimate the potential benefits and overestimate the risk of harm from invasive therapies, consequently prescribing or performing more conservative treatments [20-22]. Although high risk patients have a higher prevalence of contra-indications for several guideline recommended treatments, providing cardiologists with grounded reasons to deviate from the guidelines, a treatment-risk paradox is still apparent after a correction for the presence of these contra-indications [23]. Possibly, the presence of factors related to the healthcare provider (e.g. cardiologist) or organization is a reason for the perpetuating treatment risk paradox and variation in application of cardiac risk scores.

Wallace et al. [24] propose a four phase framework when implementing clinical prediction models/risk scores in clinical practice. After determining if factors included in the risk score are clinically sensible and appropriate (phase 1) it is recommended to determine the acceptability of the risk score among the target group by making an assessment of existing barriers and by determine ways on how to integrate the risk score into the daily workflow of the target group (phase 2). This is recommended before the actual impact of the risk score is measured (phase 3) and subsequently implemented in daily clinical practice (phase 4). In cardiac risk score use, several factors were identified that possibly explain the variation in adherence rates between hospitals regarding cardiac risk score use. These factors are consistent with previous literature regarding barriers for guideline adherence and can be divided in the following categories: guideline-, patient-, healthcare provider-, and organization-related factors [1-3]. Most barriers in cardiac risk score use were found to be related to the healthcare provider or the organization, and were derived from detailed interviews with healthcare providers. These major barriers comprised, among other, the lack of a strong scientific evidence-base and clinical relevance (i.e. impact studies), lack of motivation (i.e. intrinsic versus extrinsic), and lack of necessary resources in combination with complexity of the risk score (i.e. IT and management support). Below, the major barriers found to be related to cardiac risk score use will be elaborated on, and put in a theoretical perspective.

8.2.1 Barriers for cardiac risk score use

In the late nineties Cabana and colleagues [3] after a large systematic review developed a framework in which major barriers for physicians to adhere to clinical guidelines are presented. The different barriers were summarised in seven categories related to the different stages of behaviour change: i.e. physician's knowledge (lack of awareness, lack of familiarity),



Source: Cabana, MD, Rand CS, Powe NR, Wu AW, Wilson MH, Abboud, PA & Rubin HR. Why don't physicians follow clinical practice guidelines? A framework for improvement. JAMA 1999;282:1458-1465.

Figure 8.1 Framework of Cabana et al. [3]: barriers to physician adherence to practice guidelines

attitude (lack of agreement, lack of self-efficacy, lack of outcome expectancy, inertia of previous practice) or behaviour (external barriers, including patient-, environmental- and guideline- related barriers) (Figure 8.1). Note that physician characteristics, such as age, gender, background, and so on, are not included in the framework, because only factors that could be influenced and subsequently changed were considered.

Knowledge

Cabana et al. found that a lack of awareness and a lack of familiarity with the guideline, among others due to the amount of information in clinical guidelines, time needed to stay informed, and accessibility of the guideline contributed to a lack of knowledge. In the management of NST-ACS, there is no doubt that hospitals and cardiologists included in the different studies were aware and in great extent familiar with the content of the cardiology guidelines (e.g. ESC and ACC/AHA). However, the fast update of guidelines and frequent staff rotation of junior physicians hampered proper implementation of the scores, and made it difficult to sustain cardiac risk score use in practice. Especially as these younger physicians made up a great part of the target group i.e. (potential) direct users of cardiac risk scores in practice.

Attitudes

Cabana et al. summarized several barriers that influence physicians' attitudes towards following guideline recommendations.

First, a lack of agreement with guideline (recommendations). In the management of NST-ACS, only limited (quasi-) experimental or prognostic observational studies regarding the association between risk score use and patient outcomes have been conducted. This made cardiologists and other healthcare providers doubt the value and accuracy of these scores for clinical decision-making. Cabana et al. [3] bring up the following in their systematic review: '...since physicians see patients individually, they may not discern success at the population level. Overlooking population-level successes can negatively influence outcome expectancy and lead to nonadherence'. This also seems to be the case in risk score use in NST-ACS patients. Although clinical guidelines summarize effects on a population level of risk score use and recommend the use of these instruments in practice, this belief is not (fully) shared by healthcare providers. Furthermore, previous literature suggested that physicians might doubt whether the study populations in which the discriminative ability of the risk scores are tested properly reflected real life population of patients. Therefore a patient's actual risk may differ substantially from the risk calculated in the study with the population-based risk score. As a result physicians rather base decision-making on their own medical knowledge [25,26]. The reluctance of using risk scores due to a lack of a sound scientific evidence base became apparent in our qualitative interview study, where also the oversimplification of the process of risk assessment was brought up, i.e. management of complex clinical cases being

reduced to a single risk score. Physicians were concerned that overemphasis on risk scores may discourage good clinical judgement. This, together with the growing demands by third parties to use risk scores in clinical practice, led to resistance among its intended users. This oversimplification of the process of risk assessment is being described in Cabana's framework as 'cookbook medicine' and indeed associated with lower guideline adherence.

Second, lack of agreement was highly related with lack of clinical relevance. Clinical relevance is in Cabana's framework explained as lack of outcome expectancy, i.e. lack of belief of a physician that if the guideline (recommendation) is followed it will make a difference in terms of patient outcomes. The absence of clear benefits on a patient level of cardiac risk score use (i.e. death or re-infarction) or for clinical practice (i.e. improved continuity of care) made cardiologists doubt the added value of using a cardiac risk score. Interestingly, in a qualitative study with 68 general practitioners (GPs) based in Germany, it was found that GPs doubt the accuracy of risk scores except in the case of management of coronary heart disease [25]. In this patient population the added value of risk scores became clear because the scores supported GPs to differentiate better between patients in terms of risk and appropriate treatment. However, in our qualitative study healthcare providers mentioned that this is only the case if risk scores are integrated in existing pathways where treatment choices (in terms of performing coronary angiography or not) are depending on a patient's level of risk being partly determined by the use of cardiac risk scores.

Third, Cabana and colleagues found that a lack of motivation, i.e. the readiness for change, was a major barrier in guideline adherence. In cardiac risk score use the reason for change influenced the extent of cardiac risk score use. Extrinsic motivation i.e. external pressure, rather than intrinsic motivation accelerated implementation in Dutch hospitals. However, this primarily led to use of cardiac risk scores for administrative purposes instead of 'actual' risk score use. In case adoption of a risk score was driven by intrinsic motivations, several benefits in risk-assessment, and additionally in policy-making, education, and research were experienced which enhanced cardiac risk score use in practice. Stimulating intrinsic motivation of healthcare professionals has been described before as a successful approach to change clinical practice [27].

Behaviour

Cabana et al. [3] describe in their systematic review that behaviour, i.e. 'using a risk score or not' can be changed without influencing a physician's knowledge or attitude, but as a consequence behaviour change will be less sustainable. This accounts for risk score use as well. Several external barriers were found that influenced physician's behaviour. As explained before, in hospitals where extrinsic motivations had the overhand risk score use was solely used for administrative purposes and healthcare providers did not believe that risk scores use would

be sustained over time. In figure 8.1 it can be seen that the persistence of external barriers can negatively influence physician's outcome expectancy, self-efficacy (i.e. a physician's belief that he/she can actually perform a certain behaviour), or motivation. Several factors were found that limited healthcare providers in cardiac risk score use and were mainly related to the guideline or the organization. A major barrier was, for instance, the complexity of the risk score in combination with a lack of support or absence of necessary practical resources. In the clinical guidelines, the GRACE risk score is highlighted as being most accurate and extensively validated [4,5]. Hospitals included in our chart review, and healthcare providers participating in the qualitative study, predominantly adopted the GRACE risk score as their main instrument to stratify patients in risk classes due to the fact that this risk score had the largest scientific evidence base and was recommended by the guidelines. However, healthcare providers perceived the GRACE risk score as complex in its use, especially without sufficient IT support. This often contributed to an already high workload of healthcare providers, resulting in resistance and lack of agreement. Furthermore, as mentioned before, cardiologists decision-making regarding performing coronary angiography was primarily based on a limited number of factors, with no conclusive result regarding the impact of risk score outcomes on decision-making.

Other

In Cabana's framework several other barriers are mentioned that were not derived from any of our studies. This concerned a physician's self-efficacy (attitude). A lack of self-efficacy is mainly a barrier when physicians have to adhere to guideline recommendations concerning preventive health education or counselling strategies where it is aimed to change patient behaviour (e.g. quit smoking counselling), which is not the case in the application of risk scores. Furthermore, cardiac risk scores consist mainly of factors that physicians are familiar with from their own clinical practice and education. It does not require any new knowledge or skills.

Another barrier found in Cabana's framework, was the influence of patient preferences towards the guideline recommendations (external barriers: guideline). The inability to reconcile patient preferences with guideline recommendations, and possible resistance of patient's towards specific guideline recommendations, is a frequent mentioned barrier. However, the application of risk scores is not directly related to the patient in terms of an acquired behaviour change. This possibly explains why patient's preferences was not found to be associated with cardiac risk score use. Patient's preferences, for instance not willing to be invasively treated, could be a reason for the physician to deviate from the guideline, and makes the calculation of a risk score unnecessary.

Last, concerns about legislation of guidelines and lack of financial incentives were mentioned as external barriers in Cabana's framework. As the application of risk scores was part of a national

improvement program, and all hospital boards were obligated to follow the recommendations of the improvement program, resources in terms of finances were possibly not an issue, just as concerns about legislation of the guideline(recommendations). However, healthcare providers did mention several other resource constraints, such as a lack of IT support.

8.3 Methodological issues

There are several strengths and limitations related to the studies included in this thesis that should be taken into account.

8.3.1 Strengths

Use of multiple methods to collect data

The use of different research designs made it possible to gain a deeper understanding of the use of cardiac risk scores in clinical practice. Thus, besides insight into the extent to which they were actually used in practice, we also gained insight into the motivation for use, possible influential factors and the importance of risk scores for cardiologists' decision-making. Quantitative methods made it possible to determine the frequency of cardiac risk score use, and variation in its use. The interview study and vignette study made it possible to gather more contextual information that helped to interpret the results and to explain the variation of cardiac risk score use in practice.

Furthermore, several actions were taken to present an as reliable as possible reflection of the current standards of care in the management of NST-ACS. For instance, all available evidence regarding guideline adherence in NST-ACS care was systematically assessed, extracted and analysed independently by two researchers. Next, the patient chart review was performed in multiple hospitals, resulting in a large and representative data set of NST-ACS patients. In addition, the interview study was theory driven in which topics of the interview guide were based on a thorough assessment of available literature on guideline-implementation. Furthermore, the clinical vignettes were developed in accordance with an expert panel of cardiologists and a proper design was developed with the aid of statistical software. These aspects increased the credibility of the study results.

Representative dataset of NST-ACS patients in the Netherlands

Selection bias, in which patients are systematically excluded for instance because of their gender, age or present co-morbidities, is a common concern in clinical trial populations, but also in registry studies, and may have important implications for quality assessment [28,29]. Independent researchers therefore performed the random enrolment of patients

in our retrospective chart review study, instead of letting the treating physicians determine eligibility. In this way, we tried to minimize the chance of selection bias, thereby preventing misrepresentation of hospital performance. (Independent) cardiologists or cardiology residents employed in the participating hospitals were often consulted to verify data found in medical records, for instance in case of doubt about a patient's final diagnosis.

8.3.2 Limitations

Possible underrepresentation of actual adherence rates

The studies included in our systematic review most often concerned registry studies, which, as explained above, involve risk of selection bias. In the majority of included studies in our systematic review information on guideline adherence was prospectively collected. In some studies data was retrospectively derived from patients' medical records. This was also the method of data collection of our cross-sectional study. Data recorded in the patient's charts were not initially gathered with the purpose of measuring quality of care i.e. the extent of guideline adherence. As a consequence, information can be absent or missing, incorrectly registered or specific contra-indications providing a legit reason to deviate from the guidelines might be overlooked, as it is known that contra-indications are not always properly documented by attending physicians [30]. Consequently, our estimation of guideline adherence rates are less accurate than when data were collected prospectively. Guideline adherence rates in the systematic review or in our cross-sectional study may underestimate actual adherence rates in clinical practice. However, the impact on our conclusions regarding the extent of guideline adherence is little, as the variation in adherence rates is so large.

Representation of a real-life clinical situation

Decision-making was studied in an experimental setting, in which clinical vignettes representing actual patients were used. Although clinical vignettes are, instead of actual observations in practice, a valid approach to measure decision-making, it does not fully represent actual clinical practice. The cardiologists that participated in the study were for instance not able to observe their patients, did not experience any time-pressure, and were presented with a limited amount of clinical information. Decisions made on the basis of the vignettes can therefore be different from decisions made in actual clinical practice.

8.3.3 Generalizability

Although we put a lot of effort in selecting/recruiting a large cohort of NST-ACS patients for the patient chart review study, we approached all cardiologists registered in the Dutch directory of physicians for the clinical vignette study, and we interviewed a large group of healthcare providers employed in several Dutch hospitals, there are some limitations that may affect generalizability of the study results to other Dutch hospitals and/or countries.

Highly motivated cohort of participants

In all studies participants (either being hospitals or healthcare providers) were highly motivated to participate in scientific research, which could have influenced the generalizability of the different study results. However, in our patient chart review we collected data in multiple hospitals (n=13) and were able, in statistical analysis, to correct for random hospital effects. Also, in our qualitative study we continued interviewing until saturation was reached i.e. additional participants were interviewed up to the point no new information occurred. In our clinical vignette study, however, despite frequent reminders the non-response was unexpectedly high. Nevertheless, several markedly significant associations were found, which provided further insight in decision processes of cardiologists. Furthermore, several of our study results are comparable with previous (international) studies which supports the generalizability of the results. The descriptive character of all of the studies included in this thesis make the results informative for all hospitals/healthcare providers who want to implement a risk score, or enhance cardiac risk score use in practice.

8.4 Implications for clinical practice and future recommendations**8.4.1 Implications for future research*****Study the implementation of guideline recommendations***

In the field of implementation science it is recommended that more research should be conducted regarding how to implement the evidence in the guidelines in practice [1,27]. The same holds for the management of NST-ACS, where we recommend to study the feasibility of the implementation of the ESC and/or ACC/AHA guideline recommendations in practice. Although clinical guidelines ensure a certain standard of care, and decrease variation in care, they seem difficult to successfully implement in practice. Moreover, factors related to the healthcare provider or the organization and factors related to the guideline itself were found that influence the extent of adherence. Cardiologists mentioned, for instance, in our interview study that it is difficult to keep up with the publication of new scientific research presented in updated versions of the clinical guidelines. To illustrate, for the design of the vignette study the content of the guidelines, available risk scores and other relevant resources in relation to performing coronary angiography were reviewed. Over 100 factors were found to be related with the decision to perform coronary angiography or not. A cardiologist thus has to review over 100 possible factors in a short period of time to come to a thorough decision regarding appropriate treatment. This is of course not feasible in practice. To successfully implement the guidelines in practice – including recommendations regarding cardiac risk scores use – it is necessary to gain more knowledge regarding which (combination of) strategies are effective in overcoming certain barriers. In that way future quality improvement initiatives can select effective strategies and tailor these to the present barriers.

Study the impact of risk score use on patient outcomes

It is recommended that (more) studies are conducted in which the impact of risk scores on patient outcomes or processes of clinical care is measured. Demonstrating that using a risk score in addition to a physician's own risk assessment (versus not using a risk score) is associated with improved processes of clinical care or patient outcomes should diminish a healthcare providers resistance and lead to an increase in risk score use. A randomized controlled trial (RCT) is most optimal, a good alternative (that is also less time-consuming) is a controlled before-after design in which outcomes are measured before, during, and after using a cardiac risk score compared to outcomes of a control group in which usual care is provided [24]. Impact analyses are subjected to similar sources of bias, just as regular RCTs are, and concern randomization, blinding, sample size, and so on. An important pitfall lies the way the instruments are introduced and implemented in practice. Low usage rates of risk scores, can relate to several barriers that exists that are not thoroughly assessed and addressed before implementation [24].

8.4.2 Implications for clinical practice***Prevention of practice variation***

Given the indication that risk score use improves the processes of care and studies indicating that risk assessment is more accurate when also using a risk score it is recommended that healthcare providers involved in the management of NST-ACS patients use validated cardiac risk scores as additional support systems in their clinical decision-making. Note, we want to point out that risk scores are never meant to replace clinical judgement, or that not using a risk score is perceived as being equal to lower standards of (quality) of care. It is preferable that the scores are used as a tool to improve continuity of care, increase standardization of care, and subsequently reduce any unwarranted practice variation. With 'unwarranted' referring to practice variation that cannot be explained by characteristics of the patient (e.g. co-morbidities, type of illness or preferences), but for instance by characteristics related to the healthcare provider or organization, which seems to be mainly the case in cardiac risk score use [31]. Although physicians are continuously (implicitly) assessing complex clinical cases, the provided care is often subjected to the knowledge, attitude or behaviour of the physician, instead of available scientific evidence. Patients submitted to hospitals with underlying cardiac conditions are for instance more subjected to (unwarranted) practice variation, with negative consequences in terms of patient safety [32]. Wide-spread dissemination of risk scores can be a possible solution, but asks for implementation trajectories in which all present barriers are taken into account.

Implementation of risk scores

Several factors were found that are indicative for the extent to which risk scores will be used in clinical practice. Ideally, it is recommended that risk scores are used in addition to conventional risk assessment (i.e. clinical judgement), however several barriers were found that decreased cardiac risk score use in clinical practice. These barriers were mainly related to the healthcare provider and the organization, in terms of a skeptic attitude or resource constraints. To successfully implement risk scores in practice, and stimulate actual use, it is necessary that implementation strategies are targeted towards these present barriers and intrinsic motivation of healthcare providers is addressed (Box 8.1). It is recommended that individual cardiology departments make an assessment of local barriers, provide the necessary support and resources to integrate risk scores in existing clinical pathways or information systems, and in that way sustain cardiac risk score use over time. This undertaking also counts for future qualitative improvement initiatives. In addition, it is recommended, although more research on this topic is needed, to use a multifaceted implementation strategy, tailored to present barriers, to implement risk scores in practice and in that way enhance implementation success [2]. Grol [27] recommend a 5-step systematic approach towards implementation and achieving change in practice, which is elaborated on in Box 8.1 within the framework of enhancing cardiac risk score use.

Monitoring risk score use

It is recommended that hospitals systematically document risk score outcomes, associated treatment decisions, and patient outcomes in patients' electronic records. This to assess the extent to which cardiac risk scores are actually used in clinical practice. Note, before monitoring, it is recommended to carefully determine which information from the guidelines is used for reflection upon the quality of care and providing feedback. To monitor actual risk score use, it is recommended to use electronic health care systems. This to better grasp the interaction between the daily workflow of a physician's practice, the necessary tools and the available evidence [37]. This necessary IT support should be provided in combination with data feedback, to prevent (more) work load for individual users, but resulting in performance improvements [37]. A good example are systems designed according to the principles of intermountain health care, in which information systems of hospitals are adapted to, and integrated in, daily health care processes, which makes continuous monitoring of quality standards on a department level possible [38]. Results are promising, for instance in the field of cardiology an increase in adherence rates regarding the prescription of discharge medications and improvements in clinical outcomes was found [39].

Box 8.1 Suggestion for implementation of risk scores in practice, following the 5-step approach of Grol [27]**Step 1 – Develop a change proposal**

The first step is to develop a proposal for changing clinical practice. To increase adoption of a cardiac risk score by the target group it is important that the proposal is based on sound clinical evidence, and that any expected outcomes related to cardiac risk score use in clinical practice are clearly defined. This will increase intrinsic motivation of users regarding the use of these instruments in practice. Benefits of cardiac risk score, related to the process of care in terms of improved continuity of care or risk-assessment, can be stipulated on. Just as the evidence summed in the latest cardiac guidelines that all physicians tend to adhere to. This can be achieved by employing a combination of single implementation strategies such as reminders, feedback and the use of 'key' influential persons that can function as champions or opinion leaders.

To diminish any scepticism among healthcare providers regarding the additional benefit of risk scores for clinical practice, impact studies should be conducted and results should be disseminated among the target group. Furthermore, the risk score should be easy to use, and provided to its users in an accessible format, and in such a way that the score can be adapted to local standards. This asks for the necessary resources provided by the management, such as IT support. It is recommended that the risk score is integrated in existing pathways or digital support systems that follow daily clinical practice closely. For instance, an app which makes it possible to calculate a risk score next to a patient's bedside. Another important aspect at this stage of implementation is the way in which the risk score is introduced to the target group. Preferably by champions or opinion leaders, that have the respect of their peers.

Step 2 – Identify obstacles to change

The second is to make a thorough assessment of existing barriers related to the healthcare provider or organisation. An understanding of the problems that the target group will experience with the change is essential, and can differ among members of the target group. One person can be ready for change, where another is still considering change and not yet ready for concrete actions [33]. Actual change can be enhanced by taking away or minimizing any existing barriers. In case of cardiac risks scores, major barriers concern the adoption (e.g. negative attitude of healthcare provider) and implementation (e.g. lack of necessary resources) of the scores (see Chapter 8.2.1).

Step 3 – Link intervention to obstacle

In the third step implementation strategies are selected that tackle the present barriers. To sustain cardiac risk score use over time, it is recommended that future quality improvement initiatives make use of a multifaceted implementation strategy. Although evidence regarding the effectiveness of multifaceted implementation strategies over the use of single implementation strategies is sparse and inconclusive [34,35], a systematic review summarized several studies in which a combination of two or more single implementation strategies appear to have a greater impact [2]. It is important to select strategies targeted to improve healthcare provider's attitude and intention to change and thereby improving adoption of the scores by the target group (e.g. cardiologists). In addition, the success of the strategy is often depended on the setting in which it is employed. For instance, in hospital A, physicians are sceptical towards the use of risk scores in practice (Barrier: physician's knowledge and attitude). The use of champions (staff physicians emphasizing the importance of risk score in practice) and active management support can be important strategies in creating awareness for the additional benefits of risk score use in clinical practice. In contrast, in hospital B, physicians are willing to use

Box 8.1 Suggestion for implementation of risk scores in practice, following the 5-step approach of Grol [27] (continued)

cardiac risk scores, however they experience several barriers related to the organization, such as lack of IT support or lack of management support, which decreases the willingness and prevents them from using the risk scores in practice (Barrier: external factors/physician's behaviour). This situation asks for different implementation strategies than in hospital A. Thus, a thorough assessment of present barriers before implementation is important to achieve successful implementation of risk scores in clinical practice. In addition, strategies that require active participation of the target group and that are closely related to clinical decision-making, i.e. are more integrated into the process of health care delivery, appear to be most successful [36]. Strategies that can be considered, are audit & feedback, reminder systems, monitoring, opinion leaders.

Step 4 – Develop a plan

In the fourth step the strategies are planned in terms of concrete activities for the short- and long-term. It is recommended not to use all the strategies at once, but in a series of activities, the effects of which can directly be monitored, and used for data-feedback to the target group (e.g. cardiologists). In cardiac risk score use, it is important to first make sure that all necessary resources are provided. Even if cardiologists are motivated to use risk scores in practice, the presence of barriers that hamper the use of the scores in daily practice results in a rapid decrease of motivation. Thus, necessary IT and management support should be provided. After that, users can be educated about the use of the risk scores thus creating awareness of the benefits of the risk scores in practice. Opinion leaders can be used to emphasize the importance of using the risk scores.

Step 5 – Carry out the plan and evaluate progress

The fifth step consists of continuous evaluation which is of utmost importance to sustain cardiac risk score use over time. Furthermore, changes can occur over time: new barriers that arrive, or changes within the target group. Possibly new interventions have to be selected and the plan should be adapted. Close monitoring of the implementation process is necessary.

8.5 Conclusion

The 2015 ESC guidelines state that *‘In NST-ACS, quantitative assessment of ischemic risk by means of scores is superior to the clinical assessment alone’*. This statement, however, is not necessarily shared by healthcare providers at the point-of-care. Although cardiac risk scores are extensively validated in large cohort studies, and even in a few studies it was found that risk scores are superior to clinical assessment by physicians alone, their use in practice is relatively modest, and large variation in risk score use between hospitals exist. In addition, in a cohort of cardiologists, instead of multifactorial risk assessment as recommended by the guidelines, decision-making was primarily driven by a limited number of clinical factors.

Cardiac risk scores, however, are never meant to replace a physician's risk-assessment and decision-making regarding appropriate treatment. Not every patient meets the expectations of the guidelines in terms of risk/benefit ratio of a certain procedure, and in that case physicians have the task and responsibility to deviate from the guideline recommendation(s). However, the variation in guideline adherence and risk score use in the management of NST-ACS is too large to presume that in every patient case there were legit reasons/contra-indications to deviate from the guidelines. The care for patients with NST-ACS thus may be inadequate in terms of standardization, with as a result that not every patient is treated according to the latest scientific standards. Consequently, patients could be subjected to unnecessary therapies, or in the worst scenario experience adverse events such as re-infarction or death. It is therefore recommended that risk scores are used, *in addition to* conventional risk assessment. In that way clinical judgement, i.e. implicit decision-making based on clinical experience (subjective risk assessment), and quantitative judgement, i.e. decision-making by using risk scores (objective risk assessment) can complement and enhance each other.

Several barriers for cardiac risk score use were found, that can explain the large variation in adherence rates, and complicates the implementation of risk scores in daily practice. These barriers are related to the risk score itself, the patient, the healthcare provider and/or the organization. With emphasis on the latter two. Healthcare providers knowledge and attitude was, for instance, negatively influenced by a lack of agreement with the use of risk scores due to a lack of scientific evidence or clinical relevance of the risk score, in combination with barriers related to the risk score (complex in its use) or the organization (lack of necessary resources). As a result, instead of risk score use being mainly driven by intrinsic motivation for change, risk scores were implemented due to external pressure and consequently often used for administrative purposes only and did not actually affected decision-making regarding appropriate treatment. By contrast, healthcare providers that were intrinsically motivated to use cardiac risk scores in practice and received the necessary support, experienced benefits in for instance risk assessment and continuity of care.

Further research, regarding the impact of risk score use on patient outcomes is recommended to accelerate the implementation of these scores in practice. When implementing these scores in practice, a multifaceted implementation strategy, tailored to present barriers and in which intrinsic motivations are stimulated and the necessary resources are provided is recommended.

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